

Precipitation Reactions

Introduction: Many chemicals will not dissolve in water, so when they are made by a chemical reaction they form a cloudy precipitate of un-dissolved solids. This precipitate is an un-dissolved solid mixed into a liquid. We will use a separation technique known as filtration to separate the solid from the liquid. After finding the mass of the product we will determine the percent yield of the reaction

Solubility rules

Rule 1. All compounds of Group IA elements (the alkali metals) are soluble.

Rule 2. All ammonium salts (salts of NH_4^+) are soluble.

Rule 3. All nitrate (NO_3^-), chlorate (ClO_3^-), perchlorate (ClO_4^-), and acetate (CH_3COO^- or $\text{C}_2\text{H}_3\text{O}_2^-$,

Rule 4. All chloride (Cl^-), bromide (Br^-), and iodide (I^-) salts are soluble except for those of Ag^+ , Pb^{2+} , and Hg_2^{2+} .

Rule 5. All sulfate (SO_4^{2-}) compounds are soluble except those of Ba^{2+} , Sr^{2+} , Ca^{2+} , Pb^{2+} , Hg_2^{2+} , and Hg^{2+} , Ca^{2+} and Ag^+ sulfates are only moderately soluble.

Rule 6. All hydroxide (OH^-) compounds are insoluble except those of Group I-A (alkali metals) and Ba^{2+} , Ca^{2+} , and Sr^{2+} .

Rule 7. All sulfide (S^{2-}) compounds are insoluble except those of Groups I-A and II-A (alkali metals and alkali earths).

Rule 8. All sulfites (SO_3^{2-}), carbonates (CO_3^{2-}), chromates (CrO_4^{2-}), and phosphates (PO_4^{3-}) are insoluble except for those of NH_4^+ and Group I-A (alkali metals)(see rules 1 and 2).

Objective:

- 1) Investigate chemical reactions such as precipitation reactions dehydrations
- 2) Look at solubility rules

Safety:

Lead is a toxic metal. Gloves need to be worn whenever working with a lead based compounds. You should also avoid inhaling any lead based compounds as a dust

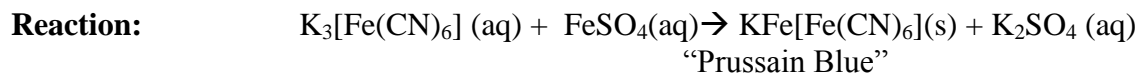
Pre-Lab Question:

How would you collect and measure the precipitate from a precipitation reaction in order to determine the percent mass? Give a detailed procedure (4-6 steps).

Procedures:

Prussian Blue

To make Prussian Blue, you need to react together two chemicals: iron (II) sulfate (FeSO_4) and potassium hexacyanoferrate (III), ($\text{K}_3[\text{Fe}(\text{CN})_6]$). They react to form a blue precipitate. This can be washed, powdered, and mixed with linseed oil to make a beautiful deep blue artists' pigment.



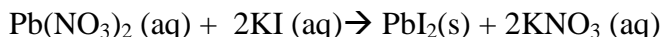
1. The first job is to make the iron(II) sulfate (FeSO_4) solution. You will need a 50ml beaker and a 10ml graduated cylinder. Write the number "1" on the flask so you know which it is.

2. Weigh out 2.0g of iron(II) sulfate (FeSO_4) into the 50ml beaker.
3. Measure 4.0ml of distilled water in the graduated cylinder. Use the plastic pipette to get it just right – take your time! Add this water to your beaker, and swirl the flask until the solid dissolves. (if you need to you may lightly warm the solution in a hot sand bath)
4. Now you need to make the potassium hexacyanoferrate(III) solution ($\text{K}_3[\text{Fe}(\text{CN})_6]$). Use another 50ml beaker and your 10ml graduated cylinder. Write the number “2” on the flask so you know which it is.
5. Carefully weigh out 1.0g of potassium hexacyanoferrate(III) ($\text{K}_3[\text{Fe}(\text{CN})_6]$) into the beaker. Measure 3.0ml of distilled water in the graduated cylinder. Again use the plastic pipette to get it just right – take your time!
6. Add this water to your beaker, and swirl the flask until the solid dissolves. (if you need to you may lightly warm the solution in a hot water bath)
7. You are now ready to make your Prussian Blue color by adding the potassium hexacyanoferrate(III) ($\text{K}_3[\text{Fe}(\text{CN})_6]$) solution (**beaker “2”**) to the iron(II) sulfate (FeSO_4) solution (**beaker “1”**). When you do this, you must:
Add the potassium hexacyanoferrate(III) ($\text{K}_3[\text{Fe}(\text{CN})_6]$) solution **DROP-BY-DROP** using a plastic pipette, and carefully swirl the contents of the flask as you add each drop.
Take your time – get it right! Remember to add the contents of flask **2** to flask **1**!

Lead Yellow

To make lead yellow, you need to react together two chemicals: potassium iodide (KI) and lead nitrate $\text{Pb}(\text{NO}_3)_2$. They react to form a yellow precipitate. This can be washed, powdered, and mixed with linseed oil to make a beautiful deep yellow artists’ pigment.

Reaction:

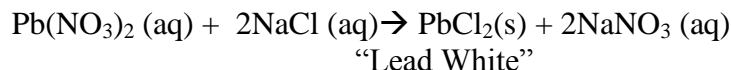


1. You will need two (2) 50ml test tubes and a 10ml graduated cylinder.
2. Weigh out 4.0g of potassium iodide (KI). Put it into a test tube labeled “1”.
3. Measure out 10ml of distilled water, and add it to the test tube. Stopper the test tube, and swirl to dissolve the solid. Take care – make sure it is all dissolved.
4. Put your gloves on, and weigh out 4.0g of lead nitrate $\text{Pb}(\text{NO}_3)_2$. Put it into a second test tube labeled “2”. Take care – this is toxic.
5. Measure out 10ml of distilled water, and add it to the tube. Stopper the tube, and swirl to dissolve all the solid.
6. You are now ready to make your lead yellow color by adding the two (2) chemicals together. Carefully pour the potassium iodide (KI), tube “1” solution into the lead nitrate solution ($\text{Pb}(\text{NO}_3)_2$), tube “2”.

Lead White

To make lead white, you need to react together two chemicals: sodium chloride (NaCl) and lead nitrate ($\text{Pb}(\text{NO}_3)_2$). They react to form a white precipitate. This can be washed, powdered, and mixed with linseed oil to make a white artists' pigment.

Reaction:



1. You will need two (2) 50ml test tubes and a 10ml graduated cylinder.
2. Weigh out 2.5g of sodium chloride (NaCl). Put it into a test tube labeled “A”.
3. Measure out 10ml of distilled water, and add it to the test tube. Stopper the test tube, and swirl to dissolve the solid. Take care – make sure it is **all** dissolved.
4. Put your gloves on, and weigh out 6.0g of lead nitrate $\text{Pb}(\text{NO}_3)_2$. Put it into a second test tube labeled “B”. Take care – this is **toxic**.
5. Measure out 10ml of distilled water, and add it to the tube. Stopper the tube, and swirl to dissolve the entire solid.
6. You are now ready to make your lead white color by adding the two (2) chemicals together. Carefully pour the sodium chloride (NaCl), tube “A” solution into the lead nitrate solution ($\text{Pb}(\text{NO}_3)_2$), tube “B”.

Post lab analysis:

1. What were the molarities for each solution that you made? SHOW ALL WORK.
 - a. Solution 1:
 - b. Solution 2:
2. What was the percent yield for your reaction? SHOW ALL WORK.

Complete the following precipitation reactions and write the net ionic equation:

6. Solutions of lead nitrate and potassium chloride are mixed.
7. Solutions of sodium sulfate and calcium bromide are mixed.
8. Solutions of aluminum acetate and lithium hydroxide are mixed.
9. Solutions of iron(III) sulfate and sodium sulfide are mixed.